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13. ABSTRACT (Maximum 200 words)

Segmentation of range images has long been considered in computer vision as an important but extremely difficult problem. A new paradigm for the segmentation of range images into piecewise continuous patches is presented. Data aggregation is performed via model recovery in terms of variable-order bi-variate polynomials using iterative regression. All the recovered models are potential candidates for the final description of the data. Selection of the models is achieved through a maximization of quadratic Boolean problem.. The procedure can be adapted to prefer certain kinds of descriptions (one which describes more data points, or has smaller error, or has lower order model). They have developed a fast optimization procedure for model selection. The major novelty of the approach is in combining model extraction and model selection in a dynamic way. Partial recovery of the models is followid by the optimization (selection) procedure where only the "best" models are allowed to develop further. The results obtained in this way are comparable with the results obtained when using the selection module only after all the models are fully recovered, while the computational eomplexity is significantly reduced. The procedure was tested on several real range images.

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Scene Segmentation and Reasoning Under Uncertainty
FINAL 1 AUG 88 - 30 SEP 91

This report covers research during the period
Our research includes the following seven areas.

(i) Color Image Segmentation.
Models were developed for detection and separation of specularities from Lambertian reflections using color and multiple images with different viewing directions.

(ii) Segmentation of 3-D Objects.
We present an integrated framework for segmenting dense range data of complex 3-D scenes into their constituent parts in terms of surface (bi-quadrics) and volumetric (superquadrics) primitives, without a priori domain knowledge or stored models.

(iii) Identification Material Properties.
We have developed a method to identify material properties such as the mass and hardness of unknown objects, using vision and manipulation. In particular, a thermal sensor has been developed that is able to determine material properties such as the product of thermal diffusivity, specific heat and specific mass.
(iv) Decision Rules for Sensor Fusion.

The purpose of this research is to examine sensor fusion problems for linear location data models using statistical decision theory (SDT). The contribution of this research is the application of SDT to obtain: (i) a robust test of the hypothesis that data from different sensors are consistent; and (ii) a robust procedure for combining the data that pass this preliminary consistency test.
(v) Optimal Fixed-Size Confidence Intervals.
Optimal Fixed-Size Confidence Intervals are used for sampling distributions which do not possess monotone likelihood ratio. Examples of this sort of distribution are the Cauchy distribution and mixtures of Gaussian and heavy-tailed distributions.
(vi) Sensorimotor Learning Using Active Perception in Continuous Domains.
The well established technique of non-parametric projection pursuit regression (PPR) is used to accomplish reinforcement learning by searching for {\em generalization directions} determining projections of high dimensional data

sets which capture task invariants.

(vii) Visual Observation.

Visual observation is discussed and formulated within a discrete event dynamic system (DEDS) framework. We describe low-level modules for defining the events that cause the state transitions within the dynamic system. In particular, we propose a system for observing a manipulation process, where a robot hand manipulates an object.